

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

### *Verified Natural Gas Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>			<i>Lifetime Gross Savings</i>
		<i>Ex Ante Therms</i>	<i>Ex Post Therms</i>	<i>Realization Rate</i>	<i>Ex Post Therms</i>
Standard	High Efficiency Boiler	4,395	9,942	226%	198,840
Standard	Boiler Lockout/ Reset Controls	20,256	5,302	26%	106,048
<b>Total</b>		<b>24,651</b>	<b>15,244</b>	<b>62%</b>	<b>304,888</b>

The total 62% verified natural gas realization rate is due to the low realization rate for boiler controls. The ex ante uses 0.32 Therms per square foot. The assumptions and values used in the ex ante are unknown, so definitive conclusions cannot be made. Typically, using savings values normalized to square footage can have a large amount of uncertainty. The square footage of the building is not the correct value to use, and that's typically what is done.

**Name** S-30, S-31, & S-32

### Executive Summary

Applications S-30, S-31, & S-32 received Standard incentives from Illinois-DCEO for retrofitting their parking garage lighting. The realization rate for this project is 97%.

### Project Description

The customer retrofitted the following:

S-30:

- (278) MH fixtures with (278) LED fixtures

S-31:

- (279) MH fixtures with (279) LED fixtures

S-32:

- (54) MH pole lamps with (54) LED pole lamps

### Methodology for Estimating Gross Savings.

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities and interviewed the site contact to verify operating hours.

#### *Standard Incentives*

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM section 4.5.4 was used.

### ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * Hours * WHF_e * ISR$$

Where:

$Watts_{base}$	= input wattage of the existing system
$Watts_{EE}$	= new input wattage of EE fixture
$WHF_e$	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

### SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * WHF_d * CF * ISR$$

Where:

WHFd = waste heat factor to account for cooling demand savings

CF = Summer Peak Coincidence Factor

## Measure-level Gross Savings Results

### *Standard Incentives*

The table shown below presents the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for Lighting Retrofit*

Measure					Annual Gross kWh Savings	
	Existing Wattage	Efficient Wattage	Hours	WHFe	Ex Ante	TRM-Calculated Ex Post
S-30 TOS/NC/RF - LED Bulbs and Fixtures	234	116.8	8766	1	283,952	285,610
S-31 TOS/NC/RF - LED Bulbs and Fixtures	234	116.8	8766	1	284,973	286,638
S-32 TOS/NC/RF - LED Bulbs and Fixtures	510	160.2	4903	1	117,855	92,614
Total					686,780	664,862

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for projects S-30, S-31, and S-32.

*Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Standard	LED Bulbs and Fixtures	283,952	285,610	101%	32.58	1,140,356
	LED Bulbs and Fixtures	284,973	286,638	101%	32.70	1,144,458
	LED Bulbs and Fixtures	117,855	92,614	79%	0.00	661,122
<b>Total</b>		<b>686,780</b>	<b>664,862</b>	<b>97%</b>	<b>65.28</b>	<b>2,945,936</b>

The overall realization rate for the three projects is 97%. Project S-32 has a low realization rate because the ex ante savings estimate was based on the fixtures being on 24/7. However, the M&V site visit revealed that the fixtures are installed on the top of the parking garage in an open air location and are only on during non-daylighting hours.

**Name** C-20

### **Executive Summary**

Application C-20 received custom incentives from Illinois DCEO for installation of DDC controls. The electric realization rate for this project is 88%, and the natural gas realization rate is 99%.

### **Project Description**

The customer installed new DDC controls. The installed controls prevent simultaneous heating and cooling that occurred with the old system.

### **Methodology for Estimating Gross Savings**

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM field staff documented equipment nameplates and controls strategies.

#### ***Custom Incentives***

Energy savings were calculated using temperature bin analysis.

Local TMY3 weather data was used to generate 2 degree temperature bins. The bins range from -10°F to 100°F. Heating and cooling profiles were assigned to the bins. ADM utilized the same heating and cooling profiles as the ex ante analysis. The cooling profile was used to calculate cooling demand for each bin. The cooling demand was calculated using the total cooling system capacity and cooling efficiency. In order to calculate the cooling energy usage for each bin, system operating hours were estimated for each bin. Total cooling energy was equal to the cooling demand multiplied by operating hours. Operating hours were calculated using a utilization factor and the number of hours in each bin. The utilization factor was determined using the ratio of total cooling runtime hours to total system runtime hours. Heating energy usage was found using the same method. Heating energy was calculated using the assumed heating profile, system operating hours, utilization factor, and total heating capacity.

Energy savings were realized from changing the pre/post heating and cooling profiles. The changes in the profiles were the results of installing DDC controls to eliminate simultaneous heating and cooling.

#### **NATURAL GAS ENERGY SAVINGS**

$$\Delta \text{Therms} = \text{Capacity} * \text{Heating Utilization Factor} * \text{Operating Hours} * (\text{Pre Heating Profile \%} - \text{Post Heating Profile \%}) / 100,000$$

Where:

Capacity = Nominal Heating Input Capacity Boiler Size (btuh)

Heating Utilization Factor = the ratio of heating runtime to total system runtime hours

= heating runtime / total system runtime

Operating Hours	= Runtime hours for each temperature bin
Pre Heating Profile %	= Percent of heating needed during temperature bin before DDC controls
Post Heating Profile %	= Percent of heating needed during temperature bin after DDC controls
100,000	= BTUs to Therms conversion

### ELECTRIC ENERGY SAVINGS

$$\Delta \text{kWh} = \text{Capacity} * 12 / \text{Cooling EER} * \text{Cooling Utilization Factor} * \text{Operating Hours} * (\text{Pre Cooling Profile \%} - \text{Post Cooling Profile \%})$$

Where:

Capacity	= Nominal Cooling Input Capacity (tons)
Cooling Utilization Factor	= the ratio of cooling runtime to total system runtime hours = cooling runtime / total system runtime
Operating Hours	= Runtime hours for each temperature bin
Pre Cooling Profile %	= Percent of cooling needed during temperature bin before DDC controls
Post Cooling Profile %	= Percent of cooling needed during temperature bin after DDC controls
Cooling EER	= Cooling Energy Efficiency Ratio
12	= EER to kW/ton Conversion

### SUMMER COINCIDENT PEAK DEMAND SAVINGS

Summer peak demand savings are assumed to be zero because the cooling profile is 100% pre and post during the peak.

### Measure-level Gross Savings Results

#### *Custom Incentives*

The tables shown below present the verified gross savings for measures that received standard incentives.

#### *Annual kWh Savings for DDC Controls*

Measure	Annual Gross kWh Savings	
	Ex Ante	ADM Calculated Ex Post
DDC Controls	14,296	12,643
Total	14,296	12,643

#### *Annual Therms Savings for DDC Controls*

Measure	Annual Gross Therms Savings	
	Ex Ante	ADM Calculated
		Ex Post
DDC Controls	652	647
Total	652	647

### Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

#### Verified Electric Savings/Realization Rates

Incentive Type	Measure Category	Annual Gross Savings				Lifetime Gross Savings
		Ex Ante kWh	Ex Post kWh	Realization Rate	Ex Post Peak kW Reduction	Ex Post kWh
Custom	DDC Controls	14,296	12,643	88%	0	189,644 <sup>28</sup>
<b>Total</b>		<b>14,296</b>	<b>12,643</b>	<b>88%</b>	<b>0</b>	<b>189,644</b>

#### Verified Natural Gas Savings/Realization Rates

Incentive Type	Measure Category	Annual Gross Savings			Lifetime Gross Savings
		Ex Ante Therms	Ex Post Therms	Realization Rate	Ex Post Therms
Custom	DDC Controls	652	647	99%	9,705
<b>Total</b>		<b>652</b>	<b>647</b>	<b>99%</b>	<b>9,705</b>

The 88% verified electric realization rate is due to differences in weather data and cooling efficiency. The ex ante did not use TMY3 weather data. ADM also used the correct cooling efficiency per manufacturer spec sheets.

The 99% verified natural gas realization rate is only slightly lower due to the use of TMY3 weather data.

<sup>28</sup> The lifetime savings were calculated by multiplying typical first year savings by the expected useful life of 15 years. California DEER Effective Useful Life worksheets: EUL\_Summary\_10-1-08.xls

**Name** S-33

### Executive Summary

Application S-33 received Standard incentives from Illinois DCEO for lighting installed in a parking garage facility. The realization rate for this project is 100%.

### Project Description

S-33 replaced (413) MH fixtures with LED fixtures in the open-air parking garage area. During the site visit, ADM also verified that each fixture was equipped with a daylight sensor that dims the light to 50% when there is daylight present.

### Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities. To verify lighting hours, ADM staff interviewed the site contact.

### Standard Incentives

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit, TRM section 4.5.4, LED Bulbs and Fixtures, was used.

### ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * Hours * WHF_e * ISR$$

Where:

Watts <sub>base</sub>	= input wattage of the existing system
Watts <sub>EE</sub>	= new input wattage of EE fixture
WHF <sub>e</sub>	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

### SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * WHF_d * CF * ISR$$

Where:

WHF <sub>d</sub>	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor



## Measure-level Gross Savings Results

### *Standard Incentives*

The table shown below presents the verified gross savings for measures that received standard incentives.

#### *Annual kWh Savings for Lighting*

<i>Measure</i>					<i>Annual Gross Therms Savings</i>	
	<i>Existing Wattage</i>	<i>Efficient Wattage</i>	<i>Hours</i>	<i>WHFe</i>	<i>Ex Ante</i>	<i>TRM-Calculated Ex Post</i>
MH to LED	218	108	8766	1.00	397,967	398,239
Total					397,967	398,239

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

#### *Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Standard	Lighting	397,967	398,239	100%	45.43	1,817,198
<b>Total</b>		397,967	398,239	<b>100%</b>	45.43	1,817,198

The realization rate for this project is 100%, which indicates a highly accurate ex ante calculation. ADM also verified the installation of daylight controls, but this measure was not in the application and a Standard incentive was not received.

**Name** S-34

### Executive Summary

Application S-34 received Standard incentives from Illinois DCEO for lighting installed in a parking facility. The realization rate for this project is 98%.

### Project Description

S-34 replaced (295) MH fixtures with LED fixtures in the open-air parking garage area, (184) 4' T8 lamps and ballasts with more efficient T8 lamps and ballasts, and (80) 3' T8 lamps with more efficient T8 lamps.

### Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities. To verify lighting hours, ADM staff interviewed site contacts.

#### *Standard Incentives*

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit, TRM sections 4.5.3 and 4.5.4 were used.

#### **ELECTRIC ENERGY SAVINGS**

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * Hours * WHF_e * ISR$$

Where:

Watts <sub>base</sub>	= input wattage of the existing system
Watts <sub>EE</sub>	= new input wattage of EE fixture
WHF <sub>e</sub>	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

#### **SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * WHF_d * CF * ISR$$

Where:

WHF <sub>d</sub>	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

## Measure-level Gross Savings Results

### Standard Incentives

The table shown below presents the verified gross savings for measures that received standard incentives.

#### *Annual kWh Savings for Lighting*

Measure	Annual Gross kWh Savings					
	Existing Wattage	Efficient Wattage	Hours	WHFe	Ex Ante	TRM-Calculated Ex Post
T8 to RWT8	32	25	8766	1.00	14,290	6,136
T8 to RWT8	59	49	3540	1.00		1,345
T8 to RWT8	24	24	8766	1.00	4,659	4,909
MH to LED	218	108	8766	1.00	284,262	284,457
Total					303,211	296,847

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

#### *Verified Electric Savings/Realization Rates*

Incentive Type	Measure Category	Annual Gross Savings				Lifetime Gross Savings
		Ex Ante kWh	Ex Post kWh	Realization Rate	Ex Post Peak kW Reduction	Ex Post kWh
Standard	Lighting	303,211	296,847	98%	34.09	4,452,705
<b>Total</b>		<b>303,211</b>	<b>296,847</b>	<b>98%</b>	<b>34.09</b>	<b>4,452,705</b>

The ex ante savings estimate slightly overestimated savings. This may be a result of an ex ante assumption that baseline fluorescent fixtures had T12 lamps and therefore had a higher wattage. The actual baseline lamps were T8. The overall realization rate is 98%.

**Name** S-35

### Executive Summary

Application S-35 received standard incentives from Illinois DCEO for installation of a water-cooled chiller, VSDs on HVAC equipment, natural gas boilers, a condensing unit heater, and a tanked natural gas water heater. The electric realization rate for this project is 81% and the natural gas realization rate is 153%

### Project Description

The customer installed the following electric equipment:

- (1) 164 ton, water-cooled scroll chiller
- (1) VFD for 7.5 HP constant volume fan
- (2) VFD for 7.5 HP chilled water pump
- (2) VFD for 15 HP chilled/hot water pump

The customer installed the following natural gas equipment:

- (2) 2,000 MBH high efficiency boilers
- (1) condensing unit heater
- (1) 60-gallon high efficiency storage water heater

### Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operational. To verify the installed equipment, ADM field staff documented photographed equipment, nameplates, and mechanical schedules. The site did not install all of the measures for which they received incentives, however. Several of the VFD measures were redundant or had been neglected. These measures are indicated as having zero ex-post savings in the *Annual kWh Savings for VFDs* table below.

### Standard Incentives

Energy savings for the electric chiller were calculated according to the Illinois TRM Version 2.0, Section 4.4.6.

### ELECTRIC ENERGY SAVINGS

$$\Delta \text{kWh} = \text{TONS} * [(12/\text{IPLV}_{\text{base}}) - (12/\text{IPLV}_{\text{ee}})] * \text{EFLH}$$

Where:

TONS	= actual installed chiller nominal cooling capacity
IPLV <sub>base</sub>	= Integrated Part Load Value efficiency of baseline equipment (EER), found in Table 503.2.3(7)
IPLV <sub>ee</sub>	= actual installed IPLV efficiency of high efficiency equipment (EER)
EFLH	= equivalent full load hours

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kW_{SSP} = \text{TONS} * [(12/PE_{base}) - (12/PE_{ee})] * CF_{SSP}$$

Where:

PE <sub>base</sub>	= peak efficiency of baseline equipment (full load EER), found in Table 503.2.3(7)
PE <sub>ee</sub>	= peak efficiency of efficient equipment (full load EER)
CF <sub>SSP</sub>	= summer system peak coincidence factor for commercial cooling = 91.3%

Energy savings for the VFDs were calculated according to the Illinois TRM Version 2.0, Section 4.4.17.

**ELECTRIC ENERGY SAVINGS**

$$\Delta kWh = kW_{connected} * \text{Hours} * ESF$$

Where:

kW <sub>Connected</sub>	= kW of equipment is calculated using motor efficiency. (HP * .746 kw/hp * load factor)/motor efficiency  Motors are assumed to have a load factor of 80% for calculating KW if actual values cannot be determined, custom load factor may be applied if known. Actual motor efficiency shall be used to calculate KW. If not known a default value of 93% shall be used.
Hours	= Default hours are provided for HVAC applications which vary by HVAC application and building type. When available, actual hours should be used.
ESF	= Energy savings factor varies by VFD application.

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kW = kW_{connected} * DSF$$

Where:

DSF	= Demand Savings Factor varies by VFD application. Values listed below are based on typical peak load for the listed application. When possible the actual Demand Savings Factor should be calculated.
-----	--

Energy savings for the natural gas boilers were calculated using the Illinois TRM Version 3.0, Section 4.4.10.

**NATURAL GAS SAVINGS**

$$\text{Therms} = EFLH * \text{Capacity} * (1/EF_{base} - 1/EF_{actual}) / 100,000$$

Where:

EFLH	= equivalent full load hours for heating
Capacity	= nominal heating input capacity for efficiency unit
EF <sub>base</sub>	= baseline boiler efficiency, dependent on year and boiler type

Effectual = actual thermal efficiency of efficient units

Energy savings for the condensing unit heaters were calculated using the Illinois TRM Version 2.0, Section 4.4.5, which gives a deemed savings of 266 Therms per unit.

Energy savings for the storage water heater were calculated using the Illinois TRM Version 2.0, which gives a deemed savings of 251 Therms for high efficiency storage hot water heaters with greater than 75 MBH capacity.

## Measure-level Gross Savings Results

### *Standard Incentives*

The tables shown below present the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for Electric Chiller*

<i>Measure</i>	<i>Measure Metrics</i>						<i>Annual Gross Savings</i>	
	<i>Program Type</i>	<i>Qty</i>	<i>Chiller Size (tons)</i>	<i>Chiller Type</i>	<i>IPLV EER</i>	<i>Peak EER</i>	<i>Ex Ante kWh</i>	<i>TRM-Calculated Ex Post kWh</i>
Electric Chiller	TOS	1	164	Water cooled, elec. operated, positive displacement	25.4	21.6	6,335	23,661
Total							6,335	23,661

*Annual kWh Savings for VFDs*

<i>Measure</i>	<i>Measure Metrics</i>					<i>Annual Gross Savings</i>	
	<i>Application</i>	<i>Program Type</i>	<i>Type</i>	<i>HP</i>	<i>Building Type</i>	<i>Ex Ante kWh</i>	<i>TRM-Calculated Ex Post kWh</i>
Variable Speed Drives for HVAC	Constant Volume Fan	TOS	HVAC	7.5	School(K-12)	4,611	5,704
Variable Speed Drives for HVAC	Constant Volume Fan	TOS	HVAC	7.5	School(K-12)	4,611	-
Variable Speed Drives for HVAC	Chilled Water Pump	TOS	HVAC	7.5	School(K-12)	4,611	4,606
Variable Speed Drives for HVAC	Chilled Water Pump	TOS	HVAC	7.5	School(K-12)	4,611	-
Variable Speed Drives for HVAC	Chilled Water Pump	TOS	HVAC	7.5	School(K-12)	4,611	4,606
Variable Speed Drives for HVAC	Chilled Water Pump	TOS	HVAC	7.5	School(K-12)	4,611	-
Variable Speed Drives for HVAC	Chilled/Hot Water Pump	TOS	HVAC	15	School(K-12)	9,222	9,746
Variable Speed Drives for HVAC	Chilled/Hot Water Pump	TOS	HVAC	15	School(K-12)	9,222	-
Variable Speed Drives for HVAC	Chilled/Hot Water Pump	TOS	HVAC	15	School(K-12)	9,222	9,746
Variable Speed Drives for HVAC	Chilled/Hot Water Pump	TOS	HVAC	15	School(K-12)	9,222	-
Variable Speed Drives for HVAC	FC Fan, discharge dampers	TOS	HVAC	.25	School(K-12)	154	-
Variable Speed Drives for HVAC	FC Fan, discharge dampers	TOS	HVAC	.25	School(K-12)	154	-
Variable Speed Drives for HVAC	FC Fan, discharge dampers	TOS	HVAC	.25	School(K-12)	154	-
Total						55,332	34,408

*Annual Therms Savings for High Efficiency Boilers*

Measure	Measure Metrics						Annual Gross Therms Savings		
	Program Type	Qty	Boiler btuh	Base Boiler type	Boiler AFUE	Zone	Ex Ante	TRM-Calculated Ex Post	TRM-Calculated (Errata Corrected) Ex Post
High Efficiency Boiler	TOS	2	2,000,000	Hot Water ≥300,000 & ≤2,500,000 Btu/h	95.0%	2 (Chicago)	4,035	6,632	6,300
Total							4,035	6,632	6,300

*Annual Therms Savings for Condensing Unit Heater*

Measure	Measure Metrics			Annual Gross Therms Savings	
	Program Type	Qty	Heater btuh	Ex Ante	TRM-Calculated Ex Post
Condensing Unit Heaters	TOS	1	24,800	266	266
Total				266	266

*Annual Therms Savings for Storage Water Heater*

Measure	Measure Metrics			Annual Gross Therms Savings	
	Program Type	Qty	Heater btuh	Ex Ante	TRM-Calculated Ex Post
Storage Water Heater	TOS	1	120,000	148	251
Total				148	251

**Project-level Gross Savings Results**

The tables shown below present the verified gross savings for this project.

*Verified Electric Savings/Realization Rates*

Incentive Type	Measure Category	Annual Gross Savings				Lifetime Gross Savings	
		Ex Ante kWh	Ex Post kWh	Realization Rate	Ex Post Peak kW Reduction	Ex Post kWh	Ex Post Peak kW Reduction
Standard	Electric Chiller	6,335	23,661	373%	18.61	473,224	18.61
	Variable Speed Drives for HVAC	65,015	34,408	53%	7.47	516,119	7.47
<b>Total</b>		<b>71,350</b>	<b>58,069</b>	<b>81%</b>	<b>26.08</b>	<b>989,343</b>	<b>26.08</b>



*Verified Natural Gas Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>			<i>Lifetime Gross Savings</i>
		<i>Ex Ante Therms</i>	<i>Ex Post Therms</i>	<i>Realization Rate</i>	<i>Ex Post Therms</i>
Standard	High Efficiency Boiler	4,035	6,300	156%	126,000
	Condensing Unit Heaters	266	266	100%	3,192
	Storage Water Heater	148	251	170%	3,765
<b>Total</b>		<b>4,449</b>	<b>6,817</b>	<b>153%</b>	<b>132,957</b>

The overall electric realization rate is 81% and the natural gas realization rate is 153% for this project.

The ex-ante electric savings estimate for electric chillers used a deemed savings of 38.63 kWh per ton for a centrifugal chiller; however, the chiller installed is a scroll/positive displacement chiller. Additional ex ante assumptions are unknown, but the TRM Version 2.0 determines hours of operation based on the air distribution system type and climate zone. This results in a realization rate of 373% for this measure. The ex-ante electric savings estimate for VFDs uses a deemed savings of 270 kWh per controlled HP based on a “school” facility type, but other assumptions are unknown. The Illinois TRM version 2.0 determines hours of operation based on HVAC application and building type and determines energy savings factor based on VFD application. Expected savings were skewed because the site did not install a number of the measures, which were redundant. Had these measures not been included, the realization rate for the VFDs would have been 107%. Including the non-installed redundant measures, the realization rate is 53%.

The ex-ante natural gas savings estimate for high efficiency boilers uses a deemed savings of 1.01 Therms per kBtuh and other assumptions are unknown. The Illinois TRM Version 3.0 determines hours of operation based on building type and climate zone. This resulted in a realization rate of 156% for this measure. The ex-ante natural gas savings estimate for storage water heaters uses a deemed savings of 148 Therms per unit for a tank size of 80 gallons; however, the actual installed water heater has a 60-gallon tank, and the Illinois TRM Version 2.0 applies a deemed savings of 251 Therms per unit for units with capacities above 75 kBtuh. The resultant realization rate is 170% for this measure.

**Name** S-36

---

**Executive Summary**

---

Application S-36 received standard incentives from Illinois DCEO for installation of an automatic door closer on a walk-in freezer. The electric realization rate for this project is 100%.

---

**Project Description**

---

The customer installed an automatic door closer on the freezer used to store perishable food items used by the cafeteria.

---

**Methodology for Estimating Gross Savings**

---

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM field staff documented the nameplate of the freezer.

***Standard Incentives***

Energy savings were calculated according to the Illinois TRM Version 2.0.

**ELECTRIC ENERGY SAVINGS**

The annual energy savings for the installation of an automatic door closer on a walk-in freezer is deemed based upon Section 4.6.1 of the Illinois TRM Version 2.0. The annual deemed savings is 2,307 kWh per year.

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

The peak demand savings for the installation of an automatic door closer on a walk-in freezer is deemed based upon Section 4.6.1 of the Illinois TRM Version 2.0. The peak demand deemed savings is .309 kW.

---

**Measure-level Gross Savings Results**

---

***Standard Incentives***

The tables shown below present the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for Automatic Door Closer*

<i>Measure</i>	<i>Program Type</i>	<i>Equipment Type</i>	<i>Annual Gross kWh Savings</i>	
			<i>Ex Ante</i>	<i>TRM-Calculated Ex Post</i>
Automatic Door Closer	RF	Walk In Freezer	2,307	2,307
Total			2,307	2,307

**Project-level Gross Savings Results**

The tables shown below present the verified gross savings for this project.

*Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Standard	Automatic Door Closer	2,307	2,307	100%	0.309	18,456
<b>Total</b>		<b>2,307</b>	<b>2,307</b>	<b>100%</b>	<b>0.309</b>	<b>18,456</b>

The 100% verified electric realization rate is due to the ex-ante analysis and ADM utilizing Illinois TRM Version 2.0 Section 4.6.1 to calculate the energy savings impacts of automatic door closers.

**Name** C-21

### Executive Summary

Application C-21 received custom incentives from Illinois DCEO for installing a ground source heat pump (GSHP) system in their facility. The electric realization rate is 112%, and the natural gas realization rate is 82%.

### Project Description

The customer installed a ground source heat pump system complete that replaced a natural gas hot water heating system and added cooling to the facility.

### Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified that the equipment was installed and operational. ADM collected updated mechanical schedules for the new system as well as a document describing the baseline system.

### Custom Incentives

ADM utilized the fuel-switching energy savings methodology guidance that ADM proposed in December 2013.

### ELECTRIC ENERGY SAVINGS

Electric energy savings are calculated as the difference in cooling and heating consumption between the as-built ground source heat pump system and an IECC 2012 code-compliant air source heat pump (ASHP) system.

$$\Delta kWh = \Delta kWh_{cool} + \Delta kWh_{heat}$$

For units with cooling capacities less than 65kbtu/h:

$$\Delta kWh_{cool} = EFLH_{cool} * Capacity_{cool} * \left( \frac{1}{SEER_{ASHP}} - \frac{1}{SEER_{actual}} \right)$$

$$\Delta kWh_{heat} = EFLH_{heat} * Capacity_{heat} * \left( \frac{1}{HSPF_{ASHP}} - \frac{1}{COP_{part load, actual}} \right)$$

For units with cooling capacities greater than or equal to 65kbtu/h:

$$\Delta kWh_{cool} = EFLH_{cool} * Capacity_{cool} * \left( \frac{1}{EER_{ASHP}} - \frac{1}{EER_{actual}} \right)$$

$$\Delta kWh_{heat} = EFLH_{heat}/3.412 * Capacity_{heat} * \left( \frac{1}{COP_{ASHP}} - \frac{1}{COP_{actual}} \right)$$

Where:

$$EFLH_{cool} = \text{Equivalent Full Load Hours for cooling (TRM version 2.0)}$$

$EFLH_{heat}$	= EFLH for heating (TRM version 2.0)
$Capacity_{cool}$	= Cooling Capacity (kBtu/h)
$Capacity_{heat}$	= Heating Capacity (kBtu/h)
$SEER_{ASHP}$	= Seasonal Energy Efficiency Ratio of code ASHP equipment
$SEER_{actual}$	= as-built SEER
$HSPF_{ASHP}$	= Heating Seasonal Performance Factor of code ASHP equipment
$HSPF_{actual}$	= as-built HSPF
$EER_{ASHP}$	= Energy Efficiency Ratio of code ASHP equipment
$EER_{actual}$	= as-built EER
$COP_{ASHP}$	= Coefficient of Performance of code ASHP equipment
$COP_{actual}$	= as-built Coefficient of Performance

#### SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = kBtu/h_{cool} * \left( \frac{1}{EER_{ASHP}} - \frac{1}{EER_{actual}} \right) * CF$$

Where:

CF	= Summer System Peak Coincidence Factor (TRM version 2.0)
	= 91.3%

#### NATURAL GAS ENERGY SAVINGS

Natural gas savings are calculated as the difference in consumption between an IECC 2012 code-compliant air source heat pump system and the existing system – in this case, a hot water boiler system.

$$\Delta Therms = Therms_{base} - Therms_{ASHP}$$

Where:

$Therms_{base}$  = existing system consumption, as determined in the ex ante savings calculation

$Therms_{ASHP}$  = code-compliant ASHP consumption,  
if cooling capacity < 65 kBtu/h:

$$= \left( \sum_{heat\ pump} kBtu/h_{heat} * \left( \frac{1}{HSPF_{ASHP}} \right) * EFLH_{heat} \right) * 3,412 \left( \frac{btu}{kWh} \right) * 10^{-5} \left( \frac{therms}{btu} \right)$$

if cooling capacity > 65 kBtu/h

$$= \left( \sum_{\text{heat pump}} \frac{kBtu/h_{\text{heat}}}{3,412 \left( \frac{btu}{h \cdot W} \right)} * \left( \frac{1}{COP_{ASHP}} \right) * EFLH_{\text{heat}} \right) * 3,412 \left( \frac{btu}{kWh} \right) * 10^{-5} \left( \frac{\text{therms}}{btu} \right)$$

HSPF = Heating Seasonal Performance Factor

COP = Coefficient of Performance

## Measure-level Gross Savings Results

### Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

*Annual kWh Savings for Ground Source Heat Pumps*

Measure	Measure Metrics						Annual Gross kWh Savings	
	kBtu/h cool	EFLH Cool	As-Built EER	kBtu/h heat	EFLH Heat	As-Built COP	Ex Ante	ADM Calculated Ex Post
Ground Source Heat Pump	3,299	819	17.17	2,553	1069	3.67	177,000	170,839
Total							177,000	170,839

*Annual Therms Savings for Ground Source Heat Pumps*

Measure	Measure Metrics			Annual Gross Therms Savings	
	kBtu/h heat	HSPF <sub>ASHP</sub>	EFLH Heat	Ex Ante	ADM Calculated Ex Post
Ground Source Heat Pump	2,553	7.7	1069	28,497	23,356
Total				28,497	23,356

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

*Verified Electric Savings/Realization Rates*

Incentive Type	Measure Category	Annual Gross Savings				Lifetime Gross Savings
		Ex Ante kWh	Ex Post kWh	Realization Rate	Ex Post Peak kW Reduction	Ex Post kWh
Custom	Ground Source Heat Pumps	177,000	197,961	112%	85.7	2,969,413
Total		177,000	197,961	112%	85.7	2,969,413

*Verified Natural Gas Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>			<i>Lifetime Gross Savings</i>
		<i>Ex Ante Therms</i>	<i>Ex Post Therms</i>	<i>Realization Rate</i>	<i>Ex Post Therms</i>
Custom	Ground Source Heat Pumps	28,497	23,356	82%	350,343
<b>Total</b>		<b>28,497</b>	<b>23,356</b>	<b>82%</b>	<b>350,343</b>

The overall electric savings realization rate is 112%, and the overall natural gas savings realization rate is 82%.

The ex ante electric energy savings calculations only considered cooling savings and were calculated as the difference in cooling consumption between a 2012 IECC compliant air cooled chiller (9.562 EER for >150 tons) baseline and the as-built ground source heat pumps. The methodology used by ADM considered 2012 IECC compliant air source heat pumps as the baseline, and calculated both heating and cooling savings resulting from the efficiency difference between the code-compliant ASHP and as-built GSHP systems. The inclusion of electric heating savings accounted for the higher realization rate.

The ex ante natural gas savings were considered to be the savings resulting from the removal of the old hot water boiler system, minus a converted kWh penalty for added heating demand from the ground source heat pumps. The ex post methodology involved a conversion of code-compliant air source heat pump electric energy use to natural gas energy use, and savings were the difference between the existing hot water boiler system and the code-compliant air source heat pump system consumption. The energy usage of the air source heat pump is a larger therms penalty, so the realization rate is lower.

**Name** C-22

## Executive Summary

Application C-22 received custom incentives from Illinois DCEO for ten retro-commissioning measures implemented at their facility. The natural gas realization rate is 185%.

## Project Description

The table below provides a summary of the implemented measures completed as a result of a retro-commissioning study conducted at the Library.

*Library RCx Measures Summary*

<i>Measure/Description</i>
<i>RCxM-1: Equipment Scheduling</i>
<i>RCxM-2: VAV Terminal Box Schedules</i>
<i>RCxM-3: Schedule Equipment for Holidays</i>
<i>RCxM-4: SAT Reset for AHUs 1-4</i>
<i>RCxM-6: Eliminate Simultaneous Heating and Cooling</i>
<i>RCxM-7: CW Temp Reset</i>
<i>RCxM-8: Static Pressure Reset</i>
<i>RCxM-9: Optimal Start/Stop</i>
<i>RCxM-10: Restore Economizer Operation</i>
<i>RCxM-11: Chiller Plant Lockout</i>

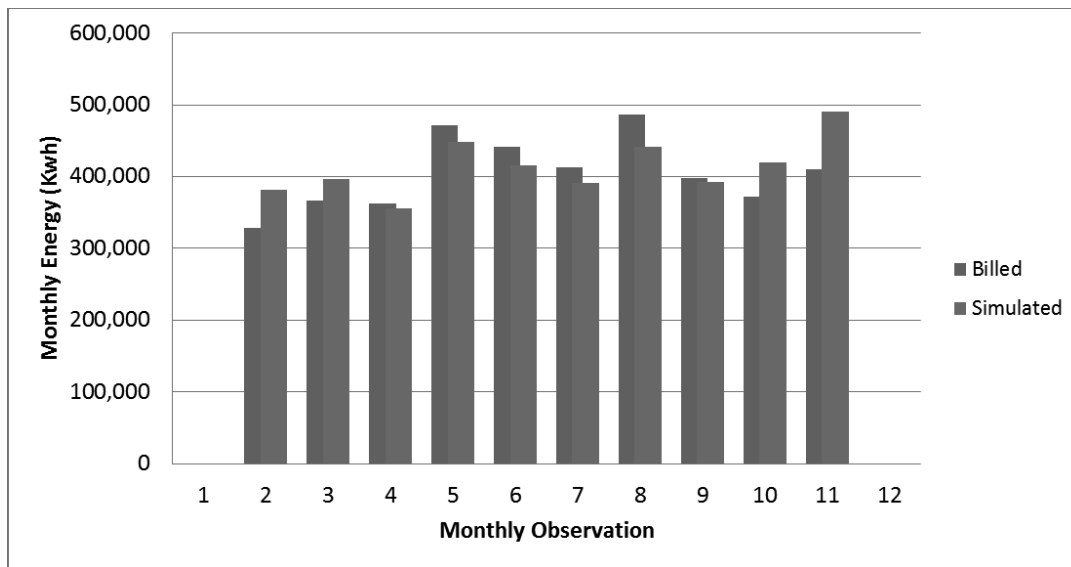
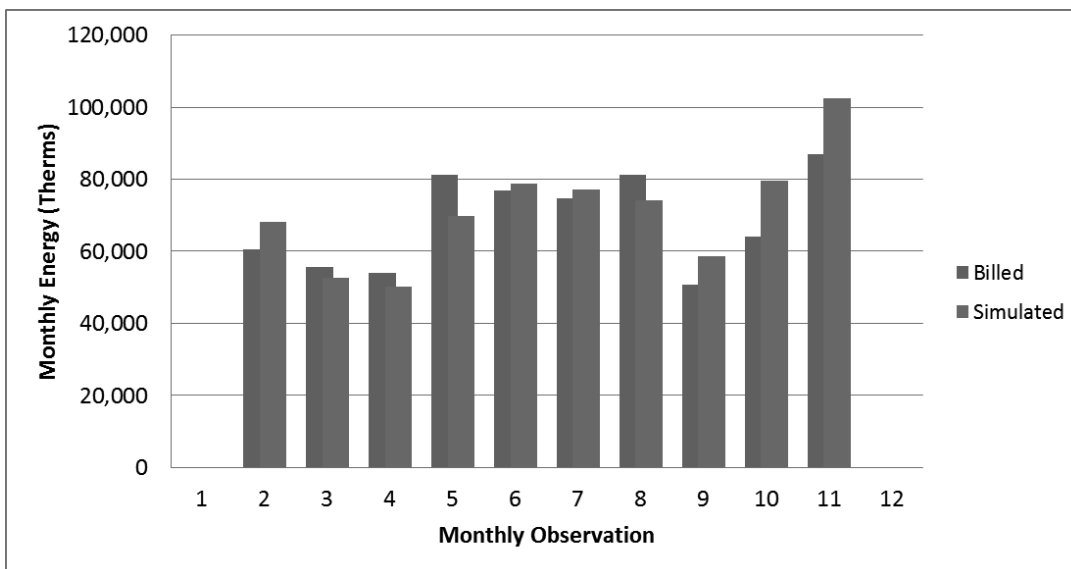
## Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified the retro-commissioning measures. To verify the energy savings for the measures, ADM field staff documented equipment nameplates, construction documents, and mechanical schedules. ADM also interviewed site contacts regarding typical facility operation and collected HVAC operational setpoints from the building's energy management system.

### *Custom Incentives*

Energy savings were calculated using an eQuest model of the fine arts center. ADM compiled a model of the baseline facility using the details and construction documents collected during the on-site M&V visit. Upon completion of the initial model, a custom weather file was created using 2012 NOAA weather data for the Southern Illinois area. Using this weather file and billing data for the facility, ADM ensured that the model's energy load shape matched that of the bills. The results of this calibration effort can be seen below:



*2012 Monthly kWh Calibration**2012 Monthly Therm Calibration*

Upon completion of the calibration for the baseline eQuest model, an as built model was created with the implemented retro-commissioning measures installed. Once the as-built model was completed, the baseline and as-built models were run using Carbondale Southern Illinois TMY3 weather data. The typical year annual savings is the difference between the two models' annual consumption and can be seen below:

*As-Built Vs. Baseline Annual Electrical Energy Consumption*

<i>End-Use</i>	<i>Baseline kWh</i>	<i>As-Built kWh</i>	<i>Annual kWh Savings</i>
<i>Lighting</i>	2,532,342	2,532,342	0
<i>Misc. Equipment</i>	455,918	455,918	0
<i>Heating</i>	0	0	0
<i>Cooling</i>	83,477	64,865	18,612
<i>Heat Rejection</i>	143,806	58,596	85,210
<i>Pumps</i>	1,555,941	1,325,876	230,065
<i>Fans</i>	635,388	232,784	402,604
<i>Exterior</i>	0	0	0
<b>Sub Total</b>	<b>5,406,872</b>	<b>4,670,381</b>	<b>736,491</b>
<i>Less RCx Program Measure 5 AHU5 OA</i>			15,810
<b>Total</b>			<b>720,681</b>

*As-Built Vs. Baseline Annual Natural Gas Energy Consumption*

<i>End-Use</i>	<i>Baseline Therms</i>	<i>As-Built Therms</i>	<i>Annual Therms Savings</i>
<i>Lighting</i>	0	0	0
<i>Misc. Equipment</i>	0	0	0
<i>Heating</i>	316,109	24,917	291,192
<i>Cooling</i>	779,434	291,144	488,290
<i>Heat Rejection</i>	0	0	0
<i>Pumps</i>	0	0	0
<i>Fans</i>	0	0	0
<i>Exterior</i>	0	0	0
<b>Sub Total</b>	<b>1,095,543</b>	<b>316,061</b>	<b>779,482</b>
<i>Less RCx Program Measure 5 AHU5 OA</i>			44,412
<b>Total</b>			<b>735,070</b>

**Measure-level Gross Savings Results***Custom Incentives*

The tables shown below present the verified gross savings for measures that received standard incentives.

*Annual Therms Savings for RCx*

<i>Measure</i>	<i>Annual Gross Therms Savings</i>	
	<i>Ex Ante</i>	<i>ADM Calculated Ex Post</i>
RCx Measures	396,843	735,070
<b>Total</b>	<b>396,843</b>	<b>735,070</b>

**Project-level Gross Savings Results**

The tables shown below present the verified gross savings for this project.

*Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Custom	Retro-Commissioning		720,681			2,767,785
<b>Total</b>			<b>720,681</b>			<b>2,767,785</b>

*Verified Natural Gas Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>			<i>Lifetime Gross Savings</i>
		<i>Ex Ante Therms</i>	<i>Ex Post Therms</i>	<i>Realization Rate</i>	<i>Ex Post Therms</i>
Custom	Retro-Commissioning	396,843	735,070	185%	3,675,350 <sup>29</sup>
<b>Total</b>		<b>396,843</b>	<b>735,070</b>	<b>185%</b>	<b>3,675,350</b>

The project has an overall natural gas realization rate of 185%. The ex post analysis used calibrated simulation; therefore, there is high certainty in realized savings. The ex ante calculations were not provided. Thus, a comparison of ex ante and ex post savings methodology was not possible.

<sup>29</sup> The lifetime savings were calculated by multiplying typical first year savings by the expected useful life of 5 years. <http://cx.lbl.gov/documents/2009-assessment/lbnl-cx-cost-benefit.pdf>

**Name** C-23

### Executive Summary

Application C-23 the customer received custom incentives from Illinois DCEO for installation of blowdown heat recovery and oxygen trim combustion controls. The natural gas realization rate for this project is 37%.

### Project Description

This project involved the installation of blowdown heat recovery and oxygen trim combustion controls. The intent of the heat recovery is to recover heat from boiler blowdown by using a heat exchanger to preheat boiler makeup water. The oxygen trim controls limit the amount of excess oxygen provided to the burner for combustion.

### Methodology for Estimating Gross Savings

During M&V, ADM staff verified the blowdown heat recovery equipment had been installed and was operating. The oxygen trim controls were installed, however, were not controlling the boilers. The site installed the controls but had boiler problems and chose to disable the oxygen trim controls to increase heating reliability through the winter. To verify the installed equipment, ADM received documented recordings of total steam and total makeup steam usage. ADM calculated ex post savings based on the site stating that the controls will be re-commissioned after the peak winter season is over.

### Custom Incentives

Engineering calculations were used to calculate the natural gas savings due to the heat recovery. US Dept. of Energy: Advanced Manufacturing Office, Recover Heat from Boiler Blowdown NREL Report No. FS-6A42-52767; DOE/GO-102012-3408 was used to determine the savings for the blowdown heat recovery. The savings were calculated using the following equation:

$$\Delta Therms = Heat\ Recovered_{interpolated} * Capacity_{boiler} * Hours / 100,000 / eff_{boiler}$$

Where:

Heat Recovered = Interpolated result using steam pressure and blowdown rate

Capacity = Capacity of the boiler

Hours = Boiler hours of operation

Eff = Efficiency of the boiler

Because the oxygen trim controls were installed but not operating, no ex-post data was available to verify savings. However, the Illinois Statewide TRM Version 3.0 includes Oxygen Trim Controls for Space Heating Boilers. The savings were calculated using the following equation:

$$\Delta Therms = Ngi * SF * Hours / 100$$

Where:

Ngi = Boiler gas input size (kBtu/hr)

SF = Savings Factor (0.87%)

Hours = Boiler hours of operation

## Measure-level Gross Savings Results

### Custom Incentives

The tables shown below present the verified gross savings for measures that received custom incentives.

*Annual Therms Savings for Boiler Measures*

Measure	Annual Gross kWh Savings	
	Ex Ante	ADM Calculated Ex Post
Blowdown Heat Recovery	45,891	101,794
Oxygen Trim Controls	808,489	217,306
<b>Total</b>	<i>845,379</i>	<i>319,100</i>

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

*Verified Natural Gas Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>			<i>Lifetime Gross Savings</i>
		<i>Ex Ante Therms</i>	<i>Ex Post Therms</i>	<i>Realization Rate</i>	<i>Ex Post Therms</i>
Custom	Blowdown Heat Recovery	45,891	101,794	222%	1,832,291 <sup>30</sup>
Custom	Oxygen Trim Controls	808,379	217,306	27%	3,911,501 <sup>30</sup>
<b>Total</b>		<b>854,379</b>	<b>319,100</b>	<b>37%</b>	<b>5,743,792</b>

The project level realization rate is 37%. The blowdown heat recovery natural gas realization rate of 222% can be attributed to the ex ante analysis using a conservative blowdown rate. The ex ante calculations used a blowdown rate of 3%; however, the actual blowdown rate was calculated to be 5.2%, taken from logged data at the site. The ex ante calculations also do not appear to account for boiler efficiency, which would further underestimate savings.

The oxygen trim controls natural gas realization rate of 27% can be attributed the ex ante analysis over estimating the savings. ADM used the Illinois Statewide TRM Version 3.0 to calculate savings for the oxygen trim controls. For comparison against the TRM calculated savings, ADM created a billing regression of 2012/13 site billing data against heating and cooling degree days. TMY3 weather data was used in the regressed formula to get weather normalized gas usage. Using the regression and ex ante pre and post efficiencies, a savings estimate was calculated. The savings were within 86% of the TRM savings which substantiates the TRM savings. The ex ante savings claimed the oxygen trim controls measure would save 17% of the site's total weather normalized annual therms usage. This would only be accurate if the boilers were running at full capacity for the entire year; however, the bills show that gas usage rises and falls with weather conditions. The gas bills are also much lower than the ex ante analysis assumes. Thus, the ex ante analysis overestimated the savings because it overestimated the gas usage of the boilers.

---

Illinois Statewide TRM Version 3.0 life span of 18 years

---

**Name** S-37, C-24

---

**Executive Summary**

---

Application S-37, C-24 received Standard incentives from Illinois DCEO for retrofitting lighting in the interior and exterior of their facilities and Standard and Custom incentives for the retro-commissioning of eight buildings along with the installation of seven ground source heat pumps. The realization rates for this project are 86% for electric and 119% for natural gas.

---

**Project Description**

---

The customer retrofitted and/or installed the following:

- Occupancy Sensors
- LED Pole lighting
- LED Parking Lot lighting
- Led wall packs and exterior lighting
- LED lighting
- LED lighting
- CFL fixtures
- Permanent delamping of T12 lamps and installation of high performance T8s in multiple buildings

In order to reduce energy consumption throughout S-37, C-24 performed retro-commissioning on eight buildings.

The retro-commissioning portion of the project consisted of repairing ill operating control and HVAC systems. Examples of the retro-commissioning repairs are as follows:

- Repair of damper actuators.
- Installation of HVAC occupancy sensors.
- Time of day temperature setbacks.
- Exhaust fan reprogramming.
- Improved building space pressurization to improve temperature and humidity control.
- Demand control ventilation programming.
- Pneumatic controls on air handlers were replaced with direct digital controls.
- Air handler dampers were calibrated, thus improving economizer control.
- Reset minimum outside air dampers on air handlers.

The site also received standard incentives for the installation of seven new 0.75 ton ground source heat pumps.

---

**Methodology for Estimating Gross Savings**

---

During the M&V visit, ADM staff documented fixture quantities and interviewed the site contact to verify operating hours, and verified that the RCx measures were completed and the ground source heat pumps had been installed and were operating. ADM also collected sub metering data for each of the buildings involved in the retro-commissioning project.

**Standard Incentives**

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM sections 4.5.1, 4.5.2, 4.5.3, & 4.5.4 were used.

**ELECTRIC ENERGY SAVINGS**

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * Hours * WHF_e * ISR$$

Where:

Watts <sub>base</sub>	= input wattage of the existing system
Watts <sub>EE</sub>	= new input wattage of EE fixture
WHF <sub>e</sub>	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * WHF_d * CF * ISR$$

Where:

WHF <sub>d</sub>	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

For the lighting controls, TRM section 4.5.10 was used.

**ELECTRIC ENERGY SAVINGS**

$$\Delta kWh = kW_{controlled} * Hours * ESF * WHF_e$$

Where:

kW <sub>controlled</sub>	= total lighting load connected to the control in kilowatts
ESF	= Energy Savings Factor
WHF <sub>e</sub>	= waste heat factor to account for cooling energy savings

**SUMMER COINCIDENT PEAK DEMAND SAVINGS**

$$\Delta kWh = kW_{controlled} * WHF_d * (CF_{baseline} - CF_{os})$$

Where:

WHF <sub>d</sub>	= heat factor to account for cooling demand savings
CF <sub>baseline</sub>	= Baseline Summer Peak Coincidence Factor
CF <sub>os</sub>	= Retrofit Summer Peak Coincidence Factor

ADM estimated the ground source heat pump energy savings according to the Illinois TRM Version 2.0, Section 4.4.9 Heat Pump Systems.



**ELECTRIC ENERGY SAVINGS**

For units with cooling capacities less than 65 kBtu/h:

$$\Delta \text{kWh} = \text{Annual kWh Savings}_{\text{cool}} + \text{Annual kWh Savings}_{\text{heat}}$$

$$\text{Annual kWh Savings}_{\text{cool}} = (\text{kBtu/h}_{\text{cool}}) * [(1/\text{SEER}_{\text{base}}) - (1/\text{SEER}_{\text{ee}})] * \text{EFLH}_{\text{cool}}$$

$$\text{Annual kWh Savings}_{\text{heat}} = (\text{kBtu/h}_{\text{cool}}) * [(1/\text{HSPF}_{\text{base}}) - (1/\text{HSPF}_{\text{ee}})] * \text{EFLH}_{\text{heat}}$$

For units with cooling capacities equal to or greater than 65 kBtu/h:

$$\Delta \text{kWh} = \text{Annual kWh Savings}_{\text{cool}} + \text{Annual kWh Savings}_{\text{heat}}$$

$$\text{Annual kWh Savings}_{\text{cool}} = (\text{kBtu/h}_{\text{cool}}) * [(1/\text{EER}_{\text{base}}) - (1/\text{EER}_{\text{ee}})] * \text{EFLH}_{\text{cool}}$$

$$\text{Annual kWh Savings}_{\text{heat}} = (\text{kBtu/h}_{\text{heat}})/3.412 * [(1/\text{COP}_{\text{base}}) - (1/\text{COP}_{\text{ee}})] * \text{EFLH}_{\text{heat}}$$

Where:

kBtu/h <sub>cool</sub>	= capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/h).
	= Actual installed
SEER <sub>base</sub>	= Seasonal Energy Efficiency Ratio of the baseline equipment; see table below for values.
SEER <sub>ee</sub>	= Seasonal Energy Efficiency Ratio of the energy efficient equipment.
	= Actual installed
EFLH <sub>cool</sub>	= cooling mode equivalent full load hours
HSPF <sub>base</sub>	= Heating Seasonal Performance Factor of the baseline equipment; see table above for values.
HSPF <sub>ee</sub>	= Heating Seasonal Performance Factor of the energy efficient equipment.
	= Actual installed
EFLH <sub>heat</sub>	= heating mode equivalent full load hours; see table above for default values.
EER <sub>base</sub>	= Energy Efficiency Ratio of the baseline equipment; see the table above for values. Since IECC 2006 does not provide EER requirements for air-cooled heat pumps < 65 kBtu/h, assume the following conversion from SEER to EER: EER ≈ SEER/1.1.
EER <sub>ee</sub>	= Energy Efficiency Ratio of the energy efficient equipment. For air-cooled air conditioners < 65 kBtu/h, if the actual EER <sub>ee</sub> is unknown, assume the following conversion from SEER to EER: EER ≈ SEER/1.1.
	= Actual installed

kBtu/h <sub>heat</sub>	= capacity of the heating equipment in kBtu per hour.
	= Actual installed
3.412	= Btu per Wh.
COP <sub>base</sub>	= coefficient of performance of the baseline equipment; see table above for values.
COP <sub>ee</sub>	= coefficient of performance of the energy efficient equipment.
	= Actual installed

### SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = (kBtu/h_{cool}) * [(1/EER_{base}) - (1/EER_{ee})] * CF$$

CF <sub>SSP</sub>	= Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)
	= 91.3%
CF <sub>PJM</sub>	= PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)

### *Custom Incentives*

### ELECTRIC ENERGY SAVINGS

Electric energy savings were calculated through the use of a variable degree day billing analysis which was performed for each individual building involved in the retro-commission project. This was accomplished by identifying the pre and post sub metering periods and creating a correlation for each, between the bills and heating/cooling degree days. The correlation creates two weather dependent terms, one being based on cooling degree days and the other heating degree days, along with a constant base energy term for the building. The baseline energy constant represents energy loads within the building that are not weather dependent. The following equation is used to express the annual energy consumption for both the baseline and as-built energy consumption:

$$kWh = m_{CDD} \times CDD + m_{HDD} \times HDD + B$$

Where:

kWh	= Annual kWh consumption
m <sub>CDD</sub>	= Cooling Degree Day Coefficient
CDD	= Annual Cooling Degree Days
m <sub>HDD</sub>	= Heating Degree Day Coefficient
HDD	= Annual Heating Degree Days
B	= Base Energy Constant

**NATURAL GAS ENERGY SAVINGS**

The same billing analysis method was repeated for buildings with gas end uses to determine the custom natural gas energy savings. This results in a very similar equation however energy consumption is reported in Therms.

$$Therm = m_{CDD} \times CDD + m_{HDD} \times HDD + B$$

Where:

Therm	= Annual Therm consumption
$m_{CDD}$	= Cooling Degree Day Coefficient
CDD	= Annual Cooling Degree Days
$m_{HDD}$	= Heating Degree Day Coefficient
HDD	= Annual Heating Degree Days
B	= Base Energy Constant

Once all baseline/as-built cooling and heating coefficients were determined for each building, TYM3 weather was used to calculate the typical annual savings for each building.

**Measure-level Gross Savings Results**

---

***Standard Incentives***

The tables shown below present the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for Lighting Retrofit*

<i>Measure</i>					<i>Annual Gross kWh Savings</i>	
	<i>Existing Wattage</i>	<i>Efficient Wattage</i>	<i>Hours</i>	<i>WHFe</i>	<i>Ex Ante</i>	<i>TRM-Calculated Ex Post</i>
TOS/NC/RF - LED Bulbs and Fixtures	455	116.8	4903	1	108,799	119,390
TOS/NC/RF - LED Bulbs and Fixtures	355	116.8	4903	1	8,304	9,343
TOS/NC/RF - LED Bulbs and Fixtures	210	116.8	4903	1	3,373	3,199
TOS/NC/RF - LED Bulbs and Fixtures	101	52.5	4903	1	9,978	4,518
TOS/NC/RF - LED Bulbs and Fixtures	200	32.2	3540	1.14	7,346	10,547
TOS/NC/RF - LED Bulbs and Fixtures	295	41	3540	1.14	-	10,250
TOS/NC/RF - LED Bulbs and Fixtures	400	160.2	3540	1.14	215,205	195,483
TOS/NC/RF - LED Bulbs and Fixtures	400	160.2	3540	1.14	-	174,193
TOS/NC/RF - LED Bulbs and Fixtures	400	160.2	3540	1.14	-	7,742
Commercial Energy Star Standard CFL			3540	1.14	6,400	20,045
RF - Fluorescent Delamping	33.7	0	3540	1.14	2,983	-
RF - Fluorescent Delamping	33.7	0	3540	1.14	227,345	106,080
RF - Fluorescent Delamping	60.3	0	3540	1.14	11,300	-
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	48	25	3540	1.14	2,019,902	1,558,613
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	48	25	3540	1.14	107,527	59,033
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	57	25	3540	1.14	15,062	17,636
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	48	25	3540	1.14	31,611	16,243
RF - High	48	25	3540	1.14	1,246	93

Measure					Annual Gross kWh Savings	
	Existing Wattage	Efficient Wattage	Hours	WHFe	Ex Ante	TRM-Calculated Ex Post
Performance and Reduced Wattage T8 Fixtures and Lamps						
Total					2,776,381	2,312,408

### Annual kWh Savings for Lighting Controls

Measure					Annual Gross kWh Savings	
	kW Controlled	Hours	ESF	WHFd	Ex Ante	TRM-Calculated Ex Post
RF - Occupancy Sensor Lighting Controls	100,000	3540	0.41	1.5	165,460	0
RF - Occupancy Sensor Lighting Controls	100,000	3540	0.41	1.5	165,460	0
Total					330,920	0

### Annual kWh Savings for Ground Source Heat Pumps

Measure	Measure Metrics									Annual Gross kWh Savings	
	Program Type	Equipment Type	Electric Resistance heat?	Qty	Cooling Capacity (kBtu/H)	Heating Capacity (kBtu/H)	SEERee	HSPFee	Zone	Ex Ante	TRM-Calculated Ex Post
GSHP	NC	Ground Source Heat Pump	FALSE	7	9	6.7	17.6	10.58	3 (Springfield)	4,081	695
Total										4,081	695

### Custom Incentives

The tables shown below present the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for RCx*

<i>Building</i>	<i>Annual Gross kWh Savings</i>	
	<i>Ex Ante</i>	<i>ADM Calculated</i>
		<i>Ex Post</i>
S A RCx		188,236
F H RCx		82,270
A D RCx		329,267
Gr H RCx		243,878
B I F RCx		613,369
T B H RCx		210,864
D K H RCx		410,287
A R RCx		367,011
Total	2,398,102	2,445,183

*Annual Therms Savings for RCx*

<i>Building</i>	<i>Annual Gross Therm Savings</i>	
	<i>Ex Ante</i>	<i>ADM Calculated</i>
		<i>Ex Post</i>
S A RCx		47,392
F H RCx		72,435
G H RCx		25,584
B I F RCx		45,923
T B H RCx		1,124
D K H RCx		12,145
A R RCx		30,906
Total	198,562	235,509

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

### *Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Standard	Compact Fluorescent Lamps	6,400	20,045	313%	5.70	93,298
	Fluorescent Delamping	241,628	106,080	44%	22.08	1,166,878
	T8 Fixtures and Lamps	2,175,348	1,651,618	76%	343.78	10,900,677
	LED Bulbs and Fixtures	353,005	534,665	151%	82.89	4,925,025
	Occupancy Controls	330,920	0	0%	0	0
	GSHP	4,081	695	17%	0.70	10,428
<i>Subtotal</i>		<i>3,111,382</i>	<i>2,313,103</i>	<i>74%</i>	<i>455.15</i>	<i>17,096,306</i>
Custom	RCx	2,398,102	2,445,183	102%	396.30	36,677,748
<i>Subtotal</i>		<i>2,398,102</i>	<i>2,445,183</i>	<i>102%</i>	<i>396.30</i>	<i>36,677,748</i>
<b>Total</b>		<b>5,509,484</b>	<b>4,758,286</b>	<b>86%</b>	<b>851.45</b>	<b>53,784,483</b>

### *Verified Natural Gas Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>			<i>Lifetime Gross Savings</i>
		<i>Ex Ante Therms</i>	<i>Ex Post Therms</i>	<i>Realization Rate</i>	<i>Ex Post Therms</i>
Custom	RCx	198,562	235,509	119%	3,532,632
<b>Total</b>		<b>198,562</b>	<b>235,509</b>	<b>119%</b>	<b>3,532,632</b>

The lighting retrofit realization rate is 74%. The occupancy sensors received a 0% realization because they were already claimed in the retro commissioning portion of this project and could not receive energy savings twice. For the delamping measures the ex post analysis verified that only a total of 780 lamps were permanently removed, while the ex ante savings estimate had 1,903 lamps being removed. The installation of high performance T8s was also overestimated in the ex ante savings estimate with a quantity of 34,028, while the ex post verified total quantity

installed was 17,794. The CFL measure had a lower ex ante savings estimate (31 kWh per lamp), while the ex post savings analysis using the TRM calculations (96 kWh per lamp) was higher. For seven of the LED measures the ex post savings analysis (ranging from 879 kWh to 1,658 kWh per lamp) was higher than the ex ante savings estimate (294 kWh to 1,511 kWh per lamp). Once the project was completed an updated application with the verified installed quantities would have resulted in a higher realization rate.

The 102% electric realization rate for the retro-commissioning project is due to the ex-ante analysis assuming a prescriptive electric and natural gas savings percentage for retro-commissioning. The ex-ante analysis assumed that the retro-commissioning would save 35% on chilled water consumption and 15% on electricity, and 25% on natural gas consumption. These savings percentages were applied without regard to the actual retro-commissioning items performed in a particular building. The 17% realization rate for the ground source heat pumps can be attributed to the ex-ante analysis entering the incorrect units in the capacity field of the Illinois TRM Version 2.0, Section 4.4.9 Heat Pump Systems calculation methodology. The ex-ante calculations entered the capacity of the installed units in “Tons” instead of “kBtu/hr” this resulted in the savings being multiplied by a factor of 12.

The electric realization rate is 86%.

The 119% verified natural gas realization rate is due to the ex-ante analysis assuming a prescriptive natural gas savings percentage for retro-commissioning. The ex-ante analysis assumed that the retro-commissioning would save 25% on natural gas consumption. This savings percentage was applied without regard to the actual retro-commissioning items performed in a particular building. The ex post analysis accounted for the actual installed measures.



**Name** S-38

### Executive Summary

Application S-38 received standard incentives from DCEO for retrofitting lighting and installation of a high efficiency boiler at their facility. The electric realization rate is 86%, and the natural gas realization rate is 127%.

### Project Description

The customer retrofitted and installed the following fixtures:

- (6) 4' 1LT12 fixtures with (6) 4' 1LT8 fixtures
- (314) 4' 2LT12 fixtures with (314) 4' 2LT8 fixtures
- (607) 4' 3LT12 fixtures with (607) 4' 3LT8 fixtures
- (469) 4' 4LT12 fixtures with (469) 4' 4LT8 fixtures
- (13) 4' 2LT12 U-tube fixtures with (13) 4' 2LT8 U-tube fixtures
- (251) MH fixtures with (251) 4' 6LT5HO fixtures
- (21) Incandescent exit signs with (21) LED exit signs

The customer installed a new high efficiency boiler. The installed boiler has an efficiency of 92.7% AFUE.

### Methodology for Estimating Gross Savings

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM field staff documented equipment nameplates.

#### *Standard Incentives*

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM sections 4.5.3, 4.5.5, 4.5.12 was used.

### ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * Hours * WHF_e * ISR$$

where

Watts<sub>base</sub> = input wattage of the existing system

Watts<sub>EE</sub> = new input wattage of EE fixture

WHF<sub>e</sub> = waste heat factor to account for cooling energy savings

ISR = In service rate = % of units rebated that get installed

### SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * WHF_d * CF * ISR$$

Where:

WHFd = waste heat factor to account for cooling demand savings

CF = Summer Peak Coincidence Factor

Energy savings were calculated according to the Errata Corrected Illinois TRM Version 3.0.

For the boiler, TRM Section 4.4.10 High Efficiency Boiler was used.

#### NATURAL GAS ENERGY SAVINGS

$$\Delta \text{Therms} = \text{EFLH} * \text{Capacity} * (1 / \text{EfficiencyRating}(\text{base}) - 1 / \text{EfficiencyRating}(\text{actual})) / 100,000$$

Where:

EFLH = Equivalent Full Load Hours for heating (see table)

Capacity = Nominal Heating Capacity Boiler Size (btuh)

= custom Boiler input capacity in Btu/hr

EfficiencyRating(base) = Baseline Boiler Efficiency Rating, dependent on year and boiler type. Baseline efficiency values by boiler type and capacity are found in the Definition of Baseline Equipment Section

EfficiencyRating(actual) = Efficient Boiler Efficiency Rating use actual value

#### Measure-level Gross Savings Results

---

##### *Standard Incentives*

The tables shown below present the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for Lighting Retrofit*

<i>Measure</i>					<i>Annual Gross kWh Savings</i>	
	<i>Existing Wattage</i>	<i>Efficient Wattage</i>	<i>Hours</i>	<i>WHFe</i>	<i>Ex Ante</i>	<i>TRM-Calculated Ex Post</i>
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	40	25	4311	1.23	368,548	477
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	78	49	4311	1.23		48,285
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	128	72	4311	1.23		180,244
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	156	94	4311	1.23		154,187
RF - High Performance and Reduced Wattage T8 Fixtures and Lamps	78	49	4311	1.23	827	1,585
RF - T5 Fixtures and Lamps	455	360	4311	1.23	173,940	126,439
RF - Commercial LED Exit Signs	35	2	8766	1.23	4,755	7,472
Total					548,070	518,689

*Annual Therms Savings for High Efficiency Boiler*

<i>Measure</i>							<i>Annual Gross Therms Savings</i>		
	<i>Program Type</i>	<i>Boiler btu/h</i>	<i>Base Boiler Type</i>	<i>Efficient Measure</i>	<i>Zone</i>	<i>Building Type</i>	<i>Ex Ante</i>	<i>TRM-Calculated Ex Post</i>	<i>TRM-Calculated (Errata Corrected) Ex Post</i>
High Efficiency Boiler	RF	1,999,999	Hot Water $\geq 300,000$ & $\leq 2,500,000$ Btu/h	Custom	2 (Chicago)	High School	2,018	2,764	2,562
Total							2,018	2,764	2,562

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

### *Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Standard	T8 Fixtures and Lamps	369,375	384,778	104%	11.81	3,110,219
	LED Exit	4,755	7,472	157%	0.11	119,553
	T5 Fixtures and Lamps	173,940	126,439	73%	3.88	1,896,582
<b>Total</b>		<b>548,070</b>	<b>518,689</b>	<b>95%</b>	<b>15.81</b>	<b>5,126,354</b>

### *Verified Natural Gas Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>			<i>Lifetime Gross Savings</i>
		<i>Ex Ante Therms</i>	<i>Ex Post Therms</i>	<i>Realization Rate</i>	<i>Ex Post Therms</i>
Standard	High Efficiency Boiler	2,018	2,562	127%	51,244
<b>Total</b>		<b>2,018</b>	<b>2,562</b>	<b>127%</b>	<b>51,244</b>

The electric realization rate is 95%. The slightly low realization rate is due to the T5 measure where the ex ante savings estimate applies a 2.15 kWh per connected watt reduced (693 kWh per fixture), where the ex post savings analysis utilized the TRM calculation result in savings of 508 kWh per fixture.

The 127% verified natural gas realization rate is likely due to TRM Version 3.0 using EFLH associated with a high school in climate zone 2. The ex ante uses 2.43 Therms per kBtuh. The assumptions and values used in the ex ante are unknown, so definitive conclusions cannot be made.

**Name** S-39

### Executive Summary

Application S-39 received Standard incentives from Illinois-DCEO for retrofitting their exterior lighting. The realization rate for this project is 139%.

### Project Description

The customer retrofitted the following fixtures:

- (1) MH fixture with (1) LED wall pack
- (13) MH fixtures with (11) LED wall packs
- (3) MH fixtures with (3) LED fixtures
- (10) MH fixtures with (10) LED fixtures
- (2) MH fixtures with (2) LED fixtures
- (2) MH fixtures with (2) LED floods
- (16) MH fixtures with (16) LED fixtures
- (2) MH fixtures with (2) LED floods

### Methodology for Estimating Gross Savings.

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities and interviewed the site contact to verify operating hours.

#### *Standard Incentives*

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM section 4.5.4 was used.

### ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * Hours * WHF_e * ISR$$

Where:

$Watts_{base}$	= input wattage of the existing system
$Watts_{EE}$	= new input wattage of EE fixture
$WHF_e$	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

### SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * WHF_d * CF * ISR$$

Where:

WHFd = waste heat factor to account for cooling demand savings

CF = Summer Peak Coincidence Factor

## Measure-level Gross Savings Results

### *Standard Incentives*

The table shown below presents the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for Lighting Retrofit*

Measure					Annual Gross kWh Savings	
	Existing Wattage	Efficient Wattage	Hours	WHFe	Ex Ante	TRM-Calculated Ex Post
TOS/NC/RF - LED Bulbs and Fixtures	295	52.5	4903	1	176	1,189
TOS/NC/RF - LED Bulbs and Fixtures	295	52.5	4903	1	5,604	15,972
TOS/NC/RF - LED Bulbs and Fixtures	188	8.3	4903	1	238	2,643
TOS/NC/RF - LED Bulbs and Fixtures	458	116.8	4903	1	15,506	16,729
TOS/NC/RF - LED Bulbs and Fixtures	458	116.8	4903	1	3,023	3,346
TOS/NC/RF - LED Bulbs and Fixtures	188	18.6	4903	1	1,433	1,661
TOS/NC/RF - LED Bulbs and Fixtures	295	18.6	4903	1	18,940	21,683
TOS/NC/RF - LED Bulbs and Fixtures	458	52.5	4903	1	3,390	3,976
Total					48,309	67,199

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

*Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Standard	LED Bulbs and Fixtures	48,309	67,199	139%	0.00	451,315
<b>Total</b>		<b>48,309</b>	<b>67,199</b>	<b>139%</b>	<b>0.00</b>	<b>451,315</b>

The project level realization rate is 139%. The realization rate is high mainly because the ex ante calculation for LED fixtures and lamps ranged between 79 kWh to 1,695 kWh per fixture, whereas the ex post savings analysis utilized the TRM calculations resulting in savings ranging from 831 kWh to 1,988 kWh per fixture. Also, the ex ante used annual hours of 4368, where the TRM hours for exterior lighting used 4,903 annual hours.

**Name** C-25

---

**Executive Summary**

---

Application C-25 received custom incentives from Illinois DCEO for installation of efficient burners on boilers. The gas realization rate for this project is 86%.

---

**Project Description**

---

The customer installed new Linkageless burners which operate using forced draft fans and direct spark ignition. They are replacing Todd Burner Assemblies burners installed in the early 1970's.

---

**Methodology for Estimating Gross Savings**

---

During the M&V visit, ADM staff verified equipment had been installed and was operating. ADM also collected equipment specifications, billing data, and combustion efficiency tests.

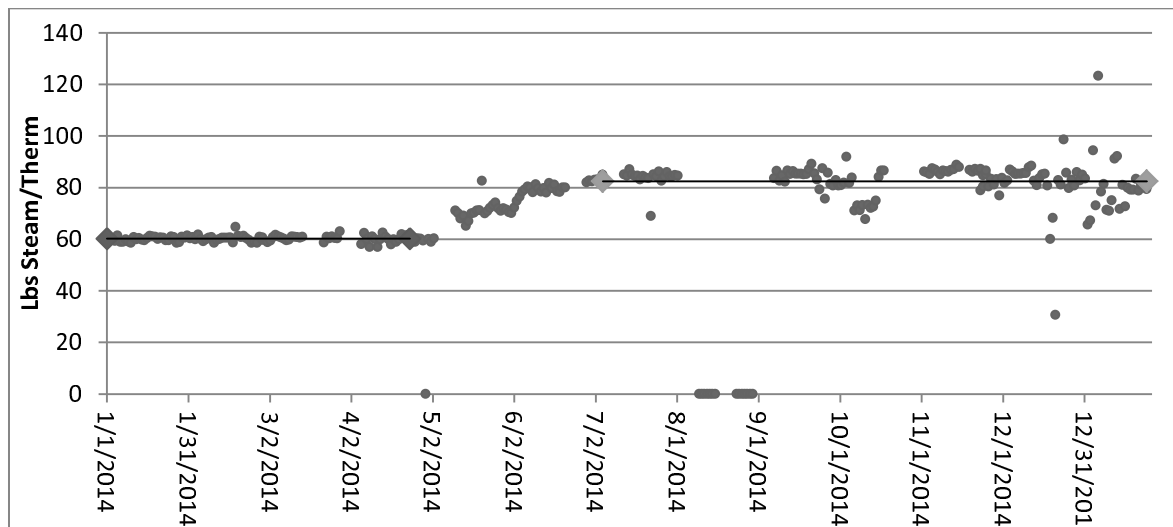
***Custom Incentives***

The facility baseline facility gas consumption documented in bills from December 2011-April 2014 was correlated to a Typical Meteorological Year (TMY3) year using Heating Degree Days (HDD) in a billing regression. The as-built consumption was unable to be correlated to the billing data because not enough winter months have passed since the installation. The as-built regression has three data points from the gas bills for October, November, and December of 2014 which is not enough to normalize the data to a typical year.

The as-built profile was created using a difference in baseline and as-built system efficiencies applied to the TMY gas use profile. The site keeps boiler combustion efficiency logs which are comprised of daily resolution gas use and steam produced. One year of this daily resolution data was collected for 2014, including 5 months of baseline data and 6 months of as-built data. The profile shows level boiler efficiency during the baseline, a period of efficiency change during the construction process, and level efficiency after construction is complete.



### Combustion Efficiency Data Pre and Post Retrofit



The as-built gas profile was calculated using the following equation:

$$\text{AsBuilt TMY Therms} = \text{Baseline TMY Therms} * \frac{\text{AsBuilt therms per lb steam}}{\text{Baseline therms per lb steam}}$$

The savings are the difference between the baseline and as-built profiles. An annual summary of the natural gas savings can be seen in the following table:

#### Monthly Therms Savings

Month	HDD	Baseline	As-Built	Savings
1	1,173	101,399	74,023	27,376
2	914	81,410	59,431	21,979
3	640	60,356	44,061	16,295
4	315	35,312	25,778	9,534
5	79	17,135	12,509	4,626
6	20	12,565	9,173	3,392
7	3	11,248	8,211	3,037
8	13	12,003	8,763	3,241
9	55	15,243	11,127	4,115
10	303	34,345	25,073	9,273
11	667	62,383	45,540	16,842
12	1,000	88,094	64,310	23,784
Total				143,495

### Measure-level Gross Savings Results

### *Custom Incentives*

The tables shown below present the verified gross savings for measures that received custom incentives.

#### *Annual Therms Savings for High Efficiency Burners*

### **Project-level Gross Savings Results**

The tables shown below present the verified gross savings for this project.

#### *Verified Natural Gas Savings/Realization Rates*

<i>Measure</i>	<i>Annual Gross Therms Savings</i>	
	<i>Ex Ante</i>	<i>ADM Calculated</i>
		<i>Ex Post</i>
High Efficiency Burners	165,603	143,495
<b>Total</b>	<b>165,603</b>	<b>143,495</b>

#### *Annual Therms Savings for High Efficiency Burners*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>			<i>Lifetime Gross Savings</i>
		<i>Ex Ante Therms</i>	<i>Ex Post Therms</i>	<i>Realization Rate</i>	<i>Ex Post Therms</i>
Custom	High Efficiency Burners	165,603	143,495	87%	2,152,422
<b>Total</b>		<b>165,603</b>	<b>143,495</b>	<b>87%</b>	<b>2,152,422</b>

The 87% verified gas realization rate is due to the ex-post calculation using measured combustion efficiencies and annualizing the savings to TMY, compared to the ex-ante which used estimated pre/post efficiencies and did not normalize to TMY operation.

**Name** C-26

---

**Executive Summary**

---

Application C-26 received custom incentives from Illinois DCEO for retrofitting the HVAC system in their facility. The electric realization rate for this project is 60%, and the natural gas realization rate is 92%.

---

**Project Description**

---

The customer retrofitted the HVAC system in SL Building. A new variable air volume system with VFD controlled fans with hot water reheat was installed to replace the old constant volume, multi-zone system.

---

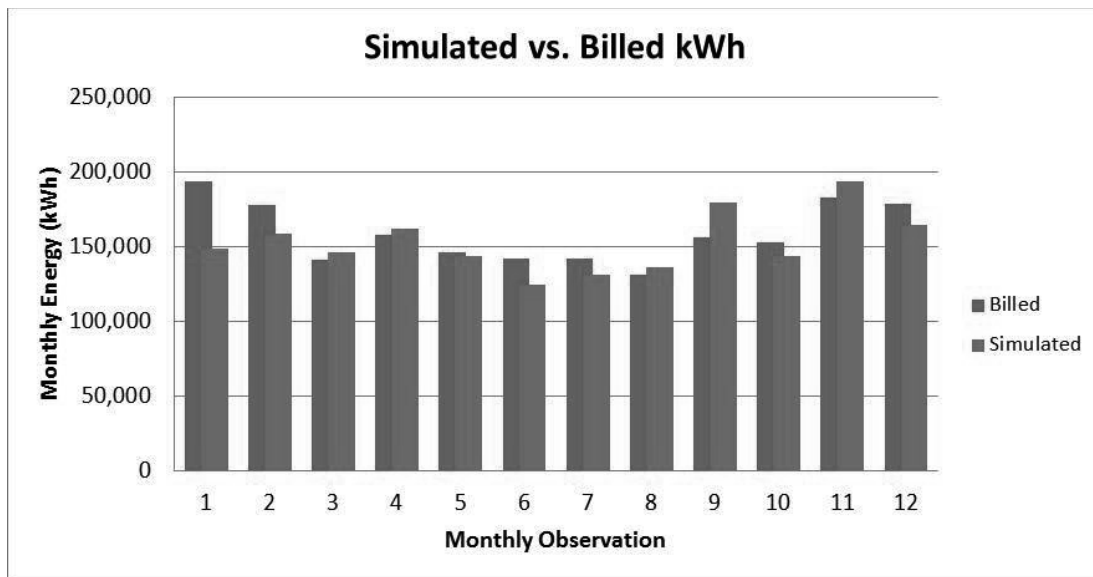
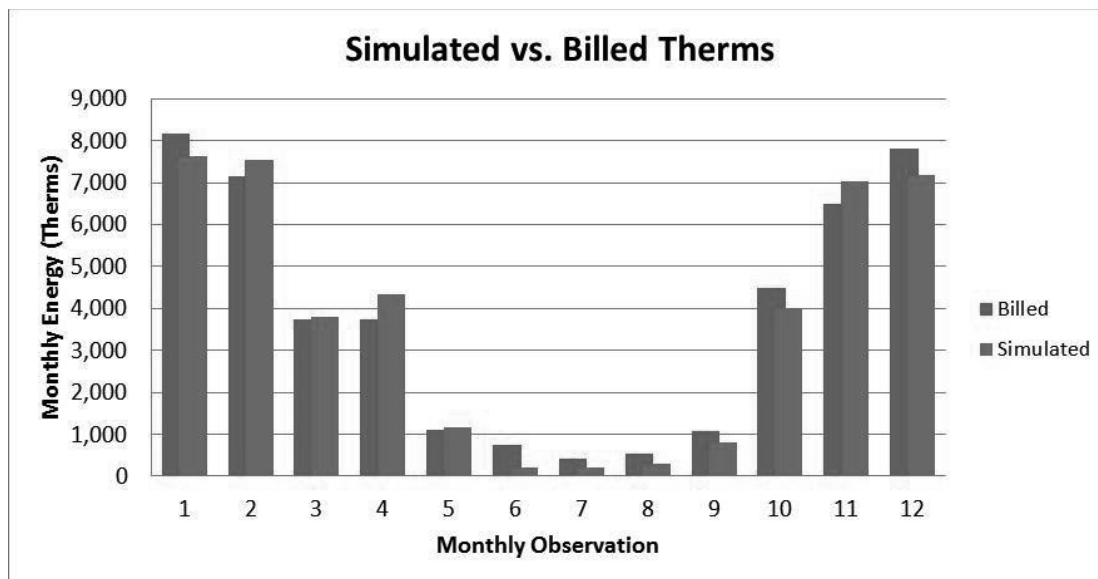
**Methodology for Estimating Gross Savings**

---

During the M&V visit, ADM staff verified that the new HVAC system had been installed. To verify the energy savings for the retrofit, ADM field staff documented equipment nameplates and mechanical schedules.

***Custom Incentives***

Energy savings were calculated using eQuest modeling of the Science Lab Building. ADM compiled a model of the baseline facility. Upon the completion of the initial model, a custom weather file was created using 2012 NOAA weather data for the Chicago Midway area. Using this weather file and billing data for the facility<sup>31</sup>, ADM was able to ensure that the model's energy load shape matched that of the bills. The results of this calibration effort can be seen below:

*2012 Monthly kWh Calibration**2012 Monthly Therms Calibration*

Upon completion of the calibration for the baseline eQuest model, an as-built model was created in which all the system type was changed to VAV and fan VFDs were implemented. Once the baseline model was completed, the baseline and as-built models were run using TMY3 weather data for the region. The typical year annual savings is the difference between the two models' annual consumption and can be seen below:

*As-Built Vs. Baseline Annual Energy Consumption*

<i>End-Use</i>	<i>Baseline kWh</i>	<i>As-Built kWh</i>	<i>Annual kWh Savings</i>	<i>Baseline Therms</i>	<i>As-Built Therms</i>	<i>Annual Therm Savings</i>
Lighting	514,581	514,581	0	0	0	0
Miscellaneous Equipment	414,646	414,646	0	0	0	0
Heating	108,147	105,628	2,519	42,550	18,822	23,728
Cooling	100,864	111,706	-10,842	0	0	0
Heat Rejection	16,204	17,818	-1,614	0	0	0
Pumps	36,813	46,250	-9,437	0	0	0
Fans	610,789	264,124	346,665	0	0	0
Domestic Hot Water	0	0	0	3,363	3,369	-6
<b>Total</b>	<b>1,802,044</b>	<b>1,474,753</b>	<b>327,291</b>	<b>45,913</b>	<b>22,191</b>	<b>23,722</b>

**Measure-level Gross Savings Results***Custom Incentives*

The tables shown below present the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for HVAC Retrofit*

<i>Measure</i>	<i>Annual Gross kWh Savings</i>	
	<i>Ex Ante</i>	<i>ADM Calculated</i>
		<i>Ex Post</i>
HVAC Retrofit: VAV & VFDs	548,800	327,291
<b>Total</b>	<b>548,800</b>	<b>327,291</b>

*Annual Therms Savings for HVAC Retrofit*

<i>Measure</i>	<i>Annual Gross Therms Savings</i>	
	<i>Ex Ante</i>	<i>ADM Calculated</i>
		<i>Ex Post</i>
HVAC Retrofit: VAV & VFDs	25,855	23,722
<b>Total</b>	<b>25,855</b>	<b>23,722</b>

## Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.

### *Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Custom	HVAC Retrofit	545,800	327,291	60%	28.85	4,909,365 <sup>32</sup>
<b>Total</b>		<b>545,800</b>	<b>327,291</b>	<b>60%</b>	<b>28.85</b>	<b>4,909,365</b>

### *Verified Natural Gas Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>			<i>Lifetime Gross Savings</i>
		<i>Ex Ante Therms</i>	<i>Ex Post Therms</i>	<i>Realization Rate</i>	<i>Ex Post Therms</i>
Custom	HVAC Retrofit	25,855	23,722	92%	355,830
<b>Total</b>		<b>25,855</b>	<b>23,722</b>	<b>92%</b>	<b>355,830</b>

The 60% verified electric realization rate is due to differences in analysis approaches. The ex-ante analysis used basic horsepower to kW calculations along with flow and runtime assumptions. The assumptions created large uncertainty. The ex post calibrated simulation used actual building and system information, which created high certainty in realized savings. Thus, the assumptions in the ex-ante analysis over estimated savings.

The 92% verified natural gas realization rate is due to the use of calibrated simulation versus engineering calculations. The discrepancy between the realized and expected savings is much lower for gas because the ex-ante analysis used some of the same system specific information. The ex-ante analysis also used the same TMY3 weather data. The main difference is that the simulation accounts for building interactive effects.

**Name** S-40

## Executive Summary

Application S-40 received Standard incentives from Illinois-DCEO for retrofitting lighting in their Student Center. The realization rate for this project is 290%.

## Project Description

The customer retrofitted the following:

- (15) 4' 4LT12 fixtures with (15) 4' LED fixtures
- (2) 2' 2LT12 U-tube fixtures with (2) 2x2 LED fixtures

## Methodology for Estimating Gross Savings.

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities and interviewed the site contact to verify operating hours.

### Standard Incentives

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM section 4.5.4 was used.

## ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * Hours * WHF_e * ISR$$

Where:

$Watts_{base}$	= input wattage of the existing system
$Watts_{EE}$	= new input wattage of EE fixture
$WHF_e$	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

## SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * WHF_d * CF * ISR$$

Where:

$WHF_d$	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

For the lighting controls, TRM section 4.5.10 was used.

## ELECTRIC ENERGY SAVINGS

$$\Delta kWh = kW_{controlled} * Hours * ESF * WHF_e$$

Where:

$kW_{controlled}$  = total lighting load connected to the control in kilowatts

ESF = Energy Savings Factor

$WHF_e$  = waste heat factor to account for cooling energy savings

### SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = kW_{controlled} * WHF_d * (CF_{baseline} - CF_{os})$$

Where:

$WHF_d$  = heat factor to account for cooling demand savings

$CF_{baseline}$  = Baseline Summer Peak Coincidence Factor

$CF_{os}$  = Retrofit Summer Peak Coincidence Factor

### Measure-level Gross Savings Results

#### Standard Incentives

The table shown below presents the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for Lighting Retrofit*

Measure					Annual Gross kWh Savings	
	Existing Wattage	Efficient Wattage	Hours	$WHF_e$	Ex Ante	TRM-Calculated Ex Post
TOS/NC/RF - LED Bulbs and Fixtures	164	53.6	3540	1.14	2308	6,683
TOS/NC/RF - LED Bulbs and Fixtures	82	44.9	3540	1.14	103	299
Total					2,411	6,982

### Project-level Gross Savings Results

The tables shown below present the verified gross savings for this project.



*Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Standard	LED Bulbs and Fixtures	2,411	6,982	290%	1.45	69,035
<b>Total</b>		<b>2,411</b>	<b>6,982</b>	<b>290%</b>	<b>1.45</b>	<b>69,035</b>

The project level realization rate is 290%. The realization rate is high because the ex ante savings estimate for the LED fixtures ranged from 52 kWh to 154 kWh per fixture, while the ex post savings analysis utilized the TRM calculations ranging from 150 kWh to 446 kWh per fixture. During the M&V site visit the number of fixtures verified was greater than the quantity on the final application provided by the project manager (which appears in this report). The quantity verified did however match the original application and the light survey.

**Name** S-41

### Executive Summary

Application S-41 received standard incentives from Illinois-DCEO for retrofitting the lighting on the exterior of their buildings. The realization rate for this project is 469%.

### Project Description

The customer retrofitted the (80) MH with (80) LED wall packs on the exterior of their site.

### Methodology for Estimating Gross Savings.

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities and interviewed the site contact to verify operating hours.

#### *Standard Incentives*

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM section 4.5.4 was used.

### ELECTRIC ENERGY SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * Hours * WHF_e * ISR$$

Where:

Watts <sub>base</sub>	= input wattage of the existing system
Watts <sub>EE</sub>	= new input wattage of EE fixture
WHF <sub>e</sub>	= waste heat factor to account for cooling energy savings
ISR	= In service rate = % of units rebated that get installed

### SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kWh = \left( \frac{Watts_{base} - Watts_{EE}}{1000} \right) * WHF_d * CF * ISR$$

Where:

WHF <sub>d</sub>	= waste heat factor to account for cooling demand savings
CF	= Summer Peak Coincidence Factor

### Measure-level Gross Savings Results

#### *Standard Incentives*

The table shown below presents the verified gross savings for measures that received standard incentives.

*Annual kWh Savings for Lighting Retrofit*

<i>Measure</i>					<i>Annual Gross kWh Savings</i>	
	<i>Existing Wattage</i>	<i>Efficient Wattage</i>	<i>Hours</i>	<i>WHFe</i>	<i>Ex Ante</i>	<i>TRM-Calculated Ex Post</i>
TOS/NC/RF - LED Bulbs and Fixtures	95	8.3	4903	1	1,681	7,652
TOS/NC/RF - LED Bulbs and Fixtures	130	18.6	4903	1	9,550	7,101
TOS/NC/RF - LED Bulbs and Fixtures	208	32.2	4903	1		4,310
TOS/NC/RF - LED Bulbs and Fixtures	188	32.2	4903	1		33,611
Total					11,232	52,673

**Project-level Gross Savings Results**

The tables shown below present the verified gross savings for this project.

*Verified Electric Savings/Realization Rates*

<i>Incentive Type</i>	<i>Measure Category</i>	<i>Annual Gross Savings</i>				<i>Lifetime Gross Savings</i>
		<i>Ex Ante kWh</i>	<i>Ex Post kWh</i>	<i>Realization Rate</i>	<i>Ex Post Peak kW Reduction</i>	<i>Ex Post kWh</i>
Standard	LED Bulbs and Fixtures	11,232	52,673	469%	0.00	376,005
<b>Total</b>		<b>11,232</b>	<b>52,673</b>	<b>469%</b>	<b>0.00</b>	<b>376,005</b>

The project level realization rate is 469%. The realization rate is high because the ex ante savings estimate (93 kWh -154 kWh per fixture) was lower than the ex post savings analysis which utilized the TRM calculations for LED fixtures (425 kWh – 862 kWh per fixture).

---

**Name** S-42

---

**Executive Summary**

---

Application S-42 received Standard incentives from Illinois-DCEO for retrofitting their lighting and HVAC. The electric realization rate for this project is 94% and the natural gas realization rate for this project is 100%.

---

**Project Description**

---

The customer retrofitted the following fixtures in their facility:

- (10) Exit signs with (10) LED Exit Signs
- (258) 4' 2LT8 fixtures with (146) 4' 2LT5 fixtures
- (80) 4' 2LT8 fixtures with (57) 4' 2LT5 fixtures
- (3) Incandescent fixtures with (2) 4' 2LT5 fixtures
- (12) Incandescent fixtures with (11) 4' 2LT5 fixtures
- Installation of Occupancy Sensors

The following improvements were installed on the facilities HVAC equipment:

- VSD for HWP 1
- VSD for HWP 2
- VSD for HV-9 Supply Fan
- VSD for HV-10 Supply Fan
- VSD for RT1 Supply Fan
- VSD for RT1 Return Fan
- VSD for RT2 Supply Fan
- VSD for RT2 Return Fan
- (2) VSD for Domestic HW Pumps
- (2) Air-Cooled Chillers in Lead/Lag
- (2) Natural Gas Tanked Water Heaters

---

**Methodology for Estimating Gross Savings**

---

During the M&V visit, ADM staff verified equipment had been installed and was operating. To verify the installed equipment, ADM staff documented fixture quantities and interviewed the site contact to verify operating hours.

***Standard Incentives***

Energy savings were calculated according to the Illinois TRM Version 2.0.

For the lighting retrofit TRM sections 4.5.5 and 4.5.12 were used.

**ELECTRIC ENERGY SAVINGS**